Background of advanced logistics systems

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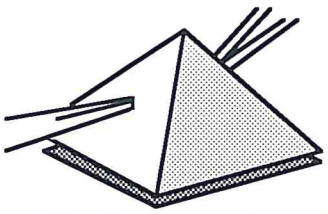

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"Advanced Logistics and Communications in Road Freight Transport Operations"

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INTRODUCTION

The objective of this report is to present the main advances in freight transportation which lead to the development of advanced logistics and communications in road freight transport operations. Our purpose is not to make an exhaustive description of all events, but to point out the most important factors, the so-called "driving-forces".

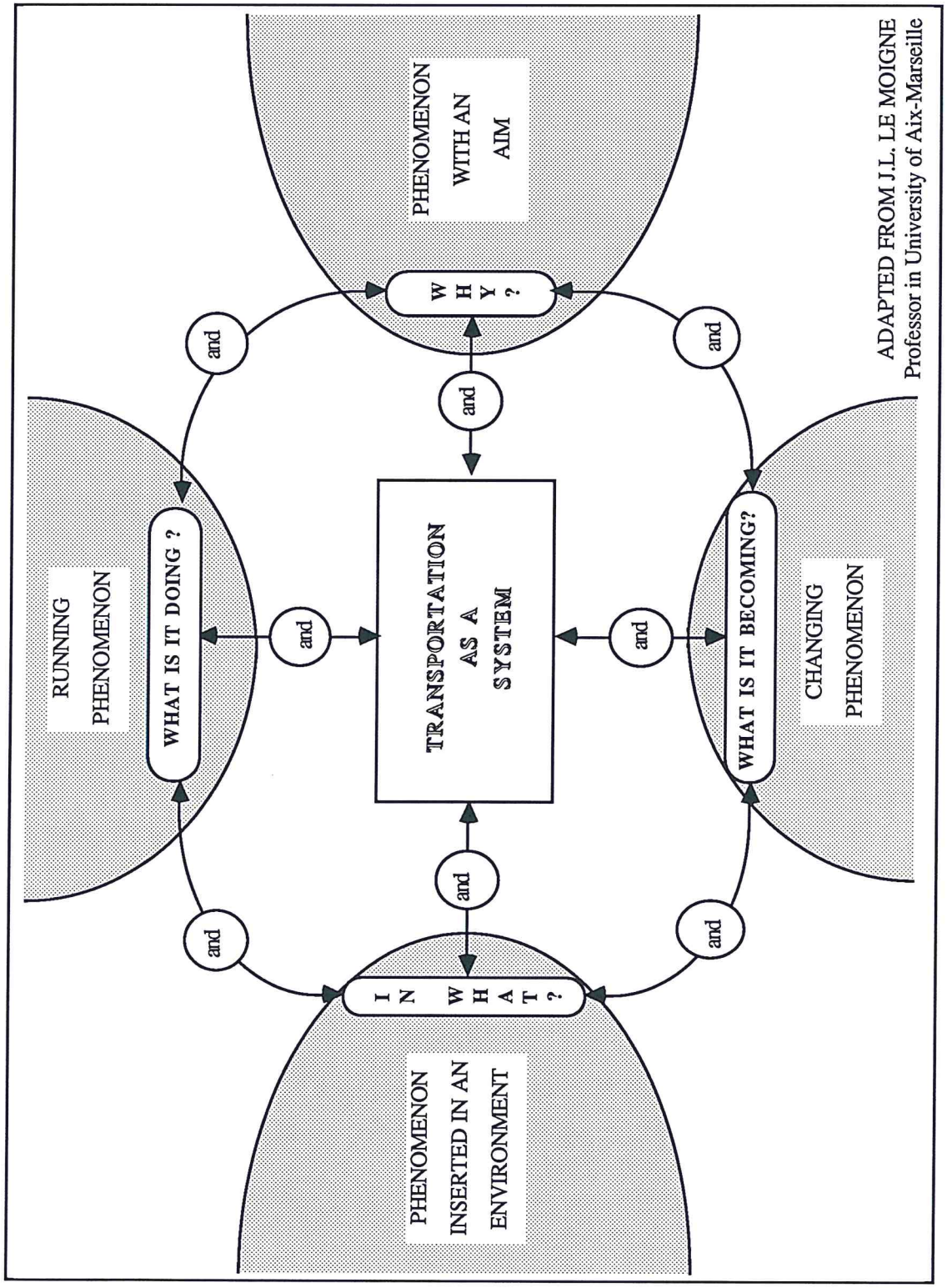
This overview of the transportation situation has been elaborated on the basis of both the materials provided by the TA1 OECD group and research in the CRET. Thus, it is available for all countries which are represented in our group. This report presents a synthesis or a "common denominator" of all the logistics backgrounds analyzed.

Due to its integration in economic and industrial activities and its relationships with policy, transportation is a very complex activity. According to us, only the systemic approach (as the one proposed by Pr. Le Moigne, illustrated on Figure 1 next page) can help us present transportation in its entire complexity.

The writing of this report follows this systemic approach, but focussing on relevant factors for each item.

- The aim of the transportation system is to fulfill the logistics demand. What are the evolutions of this demand, in particular the industrial one? See chapter 1.
- The environment in which freight transportation is inserted is also very important. We briefly examine the administrative and public policy environment in chapter 2.
- Transportation system is a running phenomenon. How are transport services provided changing? How is also the transport sector changing? See chapter 3.
- Finally, the major further evolutions in transportation, as regards information systems, are drawn up in chapter 4.

FIGURE 1 : TRANSPORTATION AS A SYSTEM



- 1 - CHANGES IN LOGISTIC DEMAND

1-1- FROM THE TRANSPORTATION DEMAND TO THE LOGISTICS DEMAND

1-1-1- THE INCREASING COMPLEXITY OF SHIPPERS DEMAND

The emergence of logistics in industry, the increasing functions it covers in firms and the real place it has in their organizations show that the control of flows has become strategic. Through the current period of stable economic development, even of harsh economic climate and increased international competition, opportunities to expand profits by expanding sales have been shrinking, and the need for cost reduction has increased. Shippers, whether they are industrial firms or distributors (wholesalers or relailers), look for a reduction of the costs of the whole physical circulation of goods. At the same time, they look for an increase in the service level they could offer to their customers. They also try to produce supply more suited to the fluctuations and hazards of markets which are diversifying, changing and becoming international. Reconsidering the whole production-distribution system, their demand is no longer to get a "pure transportation" service, but to get a complete logistic service, including services which were previously considered as subsidiary to transportation.

Firms had long transported goods for themselves. Giving up the transport on own account, shippers are now looking for transportation and logistics suppliers in order to reduce costs and enhance service levels of freight circulation. In industry, but also in distribution, a vertical "disintegration" of transportation activity has been noticed, partly because private professionnal freight carriers have shown up. This movement of subcontracting transport activities has extended to other logistics services (warehousing, inventory management, delivery for example), but provided shippers could always control the service quality and the costs of the entire chain.

The logistic demand is consequently more complex : a transport chain combines a wide range of logistic techniques and information process (See II-4). But it gives transportation firms the opportunity to take a greater part in the economic field, if they manage to offer an increased and modular supply of logistic services. The management of this complexity is an important role of advanced logistics systems. It highlights the importance of information management, in order to control physical flows.

1-1-2- CHARACTERISTICS OF SHIPPERS LOGISTIC REQUIREMENTS

More precisely, what are the characterics of the new complexity of demand and what are their impact on transportation activity? They can be divided in 3 categories : the quantity of goods that have to be transported, the quality of the required transportation service, the capacity to control transport production.

- **QUANTITY of goods that have to be transported**

The observed changes in comsumption structure and in industrial structure have direct effects on the average quantities of goods that have to be transported. In the period of high economic growth, basic demand was filled with mass production, and transportation had only to "feed" a market with great quantities of rather standardized products. In this time of stable economic growth, competition by product differentiation has been stepped up within the same market scale, and production, with many slight variations in specifications, is performed in response to fluctuation in end-consumer demand.

The industrial structure, to supply an increasingly wide variety of goods, in somewhat more limited quantities, has been changing from a heavy raw-material orientation to light assembly and processing. Thus physical flows have become lighter and the volume moved has become a more significant quantitative indicator than the weight. The general phenomenon of contracting out manufacturing activities also has an impact on physical flows, since it requires more shipments (between various plants). Production involves more transportation, and the whole process covers larger distances than before.

In parallel, because of the rapid increase in the types of products, retail stores and sales offices unless they have an adequate logistic organization are often unable to keep up coping either with a large inventory of products types or with consumer demand. Problems found in the control of inventories have been dealt with a great deal of attention for the last ten years. As practices have been improved, stock levels have steadily declined (figures of all countries represented in our group show this trend at the national level).

The first results in reducing stocks level were obtained in the retailing sector (stocks of finished goods), however inventory control now extends to the whole chain including manufacturing (stocks of work-in-process and of raw materials). The development of "just-in-time" organizations, able to follow demand fluctuations, perform strict inventory control and reduce inventories, has led to smaller quantities transported but also to more frequent deliveries.

The characteristics of quantity have a direct impact on transportation organization, in particular in the field of management systems. In order to make fleet management profitable, transportation firms have developed bulking systems and improved their physical network, structured by warehouses and break-bulk points (See II-3-1-2).

• QUALITY of the transportation service

Because of the increase in the average value and risk per load, a higher quality transport is also required. Now, more than before, shippers will select one [or only a few] operator[s] as prime contracting haulier[s], who is [are] responsible for all transport and distribution activities, even if "real transport" is contracted out. The stakes in offering the quality of the transportation service are important.

Quality, which must be obtained at the minimum cost, can be described in concrete terms by : delivering the product ordered on time, to the right place, in good condition, with good identification (bar-code or any other tag) at the correct temperature and intact, and with the appropriate documentation for accuracy and efficiency of operations. Key-words of this quality are :

Continuity of the flows of goods and of information interchanges : because chains are more and more complex and imply an increasing number of actors.

Fluidity of both flows : because of the rapid obsolescence of goods that cannot be massively stocked, and the rapid obsolescence of their associated information which have short lifetime.

Reactivity of organizations : because logistics systems have to cope with markets fluctuations and the hazards of physical operations.

Reliability of the chains which ensure the flows tension : because any disruption would lead to a loss of production or sales.

All these characteristics are demanded of logistics organizations, and explain the stakes in improving logistics systems, in particular those in charge of information management.

• CONTROL of the transport production

The quantity and quality characteristics of the demand certainly explain the greater dependence of land transportation on road transport by trucks. Road freight transportation because of its flexibility and its capacity to improve service provided seems to have an unchallengeable position in land transportation. But, because of the risks of disruption or congestion, shippers make sure that transport production is controlled and that the promised quality of the service is achieved. What are the effects of poor quality?

Any delay can paralyze the downstream links in a chain. Its effects can also spread throughout the whole chain (downstream and upstream) all the more rapidly since the organization is just-in-time.

Extra costs can be generated by disruption. The more tensed the logistics chain is, the more important the extra-costs induced by poor quality are.

Any error leads more and more frequently to direct extra costs or to an indirect disruption of service. It can even ruin all the logistics profitability.

The hazard, unavoidable in transportation, must be overcome : detection, analysis, and correcting action.

The search for eliminating inefficiencies (looking for zero delay, zero inventory, zero default, zero red tape) is certainly one of the dynamic factors which push road freight transportation to develop advanced information and communication systems.

1-1-3- TRENDS IN LOGISTIC ORGANIZATIONS OF SHIPPERS

- **Logistics is an important part of the STRATEGY of industrial firms**

Companies are now giving priority to the development of effective logistics strategies, as a key-factor of success.

Distribution is now recognized as an important part of the marketing within companies. Therefore distribution takes over finished products up to end-consumers. The first stage of this evolution was related to control of the direct cost of transportation which affect the competitiveness of products, particularly in international business. Firms then became aware that the quality of the logistic chain organization was essential in defining the service level which can be associated to the product. Nowadays, guaranteeing delivery time (for the product itself or the parts in the logistic support service) contributes to influence positively the market.

Production is no longer considered as a simple transformation process, but as a mixed and complex process in which transportation plays a key-role. Any subcontracting decision involves technical questions (capacity to produce the right part), and transportation questions (capacity to deliver the required quantity of parts in the right time, at the right place). In addition to the need for managing physical flows in the production process, many firms now consider that rythms production should be studied in accordance with the whole logistic chain (only produce what will be [or is] sold, and not try to sell what is produced).

The present position of logistics functions in firms is also revealing the greater importance it has. Earlier, there were no overall responsibilities for the control of the material flow between different departments in a company. Companies have (in general gradually) established a special department of logistics in charge of all the planning, coordination and control of the physical flow in the whole chain, including production and up to the supplying of raw materials.

Aside from its impacts on industrial process, logistics is a powerful changing factor of distribution structures. It has permitted the nation-wide grouping of department stores and large supermarkets, the concentration of wholesalers and retailers (covering up the whole nation-wide area), an increase in stores (in number and surface) using chain store management methods... It has also permitted the diversification of distribution forms : specialized mass selling stores (shoes, clothes, do-it-yourself parts...), or even selling without stores like mail-order (even telematic-order) selling, or door-to-door selling...

• Logistics permits to increase the physical and marketing AREA of firms

The size of the operating area of both manufacturers and distributors is extending up to the continent level (the case in Europe with the "1993 horizon" and its accelerating effects of firms strategies), and even to the world level (the case for international firms). Logistics not only allows manufacturers and distributors to increase the standing of all the production factors, but can also mobilize them with efficiency to cover wider markets. Trends in physical setting up confirm that logistics can support expanding strategies, but often with a concentration of both production and distribution centers that increases the need for transportation.

Logistics gives above all a precious help in arbitration leading to new choices and policies. For example, many manufacturers (in particular those working with stockless systems) reduce the overall number of suppliers, and eliminate those suppliers situated in areas with no possibilities for high transport service. Such suppliers will be replaced by others unless the parts are somehow unique, have a low volume value, or combine high labor content with a particularly low price.

The development of logistics shows that the concept of market-oriented production (in a broad sense) is not restricted by the borders of a unique company, but is widenning out to all companies involved in the logistic chain. The concept of logistic chain is directly associated to the concept of "network-firm". To ensure short-term efficiency, the operating times of the different operations performed by a "network firm" have to be coordinated (if they are not simultaneous). To perform long-term efficiency, the network-firm has to structure correlated mutual planning including transportation firms.

Because many of the partners linked in the "network firm" are scattered, there is a need for powerful communication networks, and common information systems. The management of the international area will accelerate the development of advanced logistics systems. It will also put through a riddle the transportation firms : the "mono-firms" nationally-centred will probably be marginalized. Those who will not have information and communication systems will probably be subcontractors of major companies to whom they will probably "pay access" to their networks (the transportation one and the communication one).

- **Logistics improves the INTERNAL organization**

Following a marketing process, industrial and retailing companies are now superposing two kinds of logistics chains.

A proactive logistics for internal coordination guarantees the best cost for routing flows that are regular, massive, recurrent, and easy to plan for.

A reactive logistics for external synergism is imagined to forward the other flows. Although difficult to foresee, those flows are often urgent and demand the intervention of a great number of partners in the "network-firm".

This movement confirms once more the diversification in transportation demand. Will the service offered by transportation suppliers fit with the new industrial organization? How will they manage to perform the service? What are the effects on the transportation sector?

- 2 - MAIN EVOLUTION IN TRANSPORT ENVIRONMENT

2-1- ABOUT ADMINISTRATIVE ENVIRONMENT

Logistics activities are far from being free of regulation, but they are not all in the same situation. If inventory control is usually free of regulation, both transportation (in particular road transportation) and warehousing are controlled by the regulatory powers of central and local governments, particularly at the planning stage. But some important modifications have occured in regulation, and are in a way responsible for the development of advanced logistics systems.

2-1-1- ADMINISTRATIVE REGULATION IN TRANSPORTATION

• Towards liberalization

In most countries, the road freight industry comprises two sectors : the own-account sector (manufacturers or retailers who run their own fleet of vehicles to carry their own goods) and the haulage or for-hire sector (operators who carry the goods of others for hire or reward). The professional carriers of the haulage sector were regulated in many ways. In most countries there were strict controls on the entry in the haulage sector, in general with a regulatory regime of licences (or certificates), on tariffs (compulsory price scale) and even on the kind of services provided. In haulage supply, both the number of operators that were allowed to provide services, and the number of vehicles that could be operated were limited. Rates and fares were also closely regulated.

What was a classical economic regulation system with very strict application first (in the beginning of the 70s) became in many countries, particularly in Europe, more flexible in its application. For example, in most countries tariff regulation by the government became ineffective, and unregulated (illegal) tariffs dominated the market. Now most countries have changed their regulation regime, adapting it to the reality of the transportation sector and to the shippers' demand. Road haulage sector is becoming more shipper-oriented (in terms of services and tariffs) and more accessible to newcomers (less entry barriers), even if a control (with quality criteria) still exists.

If the general movement in road transportation has developed towards liberalization, the elimination of national and international (the case of EEC) regulations has not occured, and will probably never be.

The reform of transport regulation has certainly stimulated vitality and creativity in transportation. Liberalization is certainely urging transportation firms to develop advanced logistics and communications systems, because it has created a new competitive situation.

• **Effects of cost regulation**

The present relative commercial autonomy in the transport sector is a very recent development brought about by "deregulation" (liberalization would probably be a better term). Even if freedom to set tariffs is still far from being total, the regulation with less intervention of government is more market-driven than before. Because of the liberalization of the entry in the road haulage sector, many companies are now competing with each other for freight. The present cost regulation is a direct effect of the development of greater competition.

This cost regulation has two impacts on the transportation sector. The first is that transportation firms are compelled to develop new services in order to become differentiated from the others. Among the services that can be developed, those performed by information and communication systems seem to be the most efficient. The second is that because of the low transport rates, which result from competition, it becomes more difficult to develop those systems, which are in general very expensive.

It seems that only a few transport companies will succeed in developing advanced logistics systems, probably the bigger ones and those who have other logistics activities beside transportation. As a result, the immense scale of some non-material investment ploughed back into computerized systems will probably create an irreversible situation in the transport sector. In some high transportation services, the entry-costs to any newcomer will be so high that there will be no other choice than to join the organization and pay the price for it, or to disappear.

Some new policy requirements will perhaps be necessary to restore some "equity" in the transportation sector if too many problems arise because of disadvantages. If the re-regulation of the transport sector is now unlikely, it could be the objective of a new telecommunication policy.

• **Towards social cost regulation**

Because of the growing environmental movement, a social cost regulation could now be imposed by transportation impacts on the environment and by the resulting ecological sensitiveness. In order to distribute resources rationally, in view of resource limitations and strict environmental regulations, a variety of measures are currently being discussed to encourage appropriate modal-split between railroads and roads, as well as to promote long-distance transportation using the advantages of railroads.

2-1-2- ABOUT INFRASTRUCTURE PLANNING

Even if the logistics performance of an individual company can be improved considerably only by adopting new management principles, large investments in hard-, soft- and "orgware" are needed to achieve long term improvements for a whole industry or region. The logistics infrastructure sets the limits for logistic productivity improvements, and conversely infrastructure improvements give long term logistic benefits to industry and can also be a changing agent for accelerated developments.

In this matter the road freight transportation sector is directly concerned by road infrastructure planning. In particular, the design of road networks, as well as the warehousing policy, have a significant impact on company location.

- **ROAD planning**

Decisions about main infrastructures still remain in the state sector, at least in the public sector (it can be local administration decisions), if they are not supra-national decisions as it is becoming in the EEC. In road freight transportation, decisions are taken on road planning, financing, and also maintenance (except when highways are exploited by private firms).

All logistitic organizations have first developed themselves into an infrastructure situation with relative over capacity. Today, arising problems of saturation of infrastructure and environmental risks (because of sensitive goods, but also in relation with general nuisance like noise and general risks such as accidents) will probably lead to new political decisions.

The development of advanced logistics organizations (in particular JIT) leads to greater utilization of infrastructure (problem of increased costs of maintenance), and to traffic congestion, with the problem of growing conflict between passenger and freight vehicles. Some decisions will have to be taken to manage this situation. Must infrastructure be increased, and environmental nuisance too? If they must, who will bear the cost of the further infrastructure required to meet traffic demand (construction and maintenance costs)? Must transportation be more regulated (urging to use railroads or shipping)? Or can systems be implemented in order to technically regulate the traffic, or to avoid some congestion? But, again, who will pay for that?

These questions are very important for most countries, in particular for those who lack space (the case of Japan), or those who are environmental sensitive (the case of Europe). They are particularly important for main cities which are facing a dramatic situation of traffic polarization. It is noticed in some cities already, large trucks are not allowed through their central area.

• **WAREHOUSES planning**

In this context, warehouses planning must be taken into account. Advanced logistics systems in road transportation are in most cases based on mixed logistic activities involving warehousing and stockholding. These operations which used to be managed by wholesaling companies, or directly by manufacturers or retailers, are now subcontracted to logistics suppliers who invest in warehouses or in break-bulk points. Thus, aside the infrastructure field but totally related to it (See II-3-2), we must take into account planning policies in warehouses development.

In contrast to transportation, which is mostly controlled centrally, control over warehousing is mainly the responsibility of "local governments". The power of local authorities can be applied to existing warehouses (for example in response to complaints about nuisances) or to plans that companies have for new warehousing development. In this last category, local authorities have in general an important role, they can even prevent the development of a warehouse at a location considered unsuitable.

The past few years have shown an accelerating movement of the concentration of logistics functions, clustered around a relatively small number of major centers. The centralization of stockholding has caused warehousing to gravitate towards the major centers of population and industrial activity. Much of the logistics activities have now moved from inner urban areas where their efficiency is impaired by difficult vehicle access, lack of room for expansion and often antiquate buildings, to decentralized areas, generally in proximity to motorways. But they still stay around the major centers, reinforcing the saturation problems of infrastructures ending up in these areas. In some countries (especially in Japan) an inverse tendency can also be observed : logistic terminals are located in inner areas to reduce costs of final transfers and to easily get man-power.

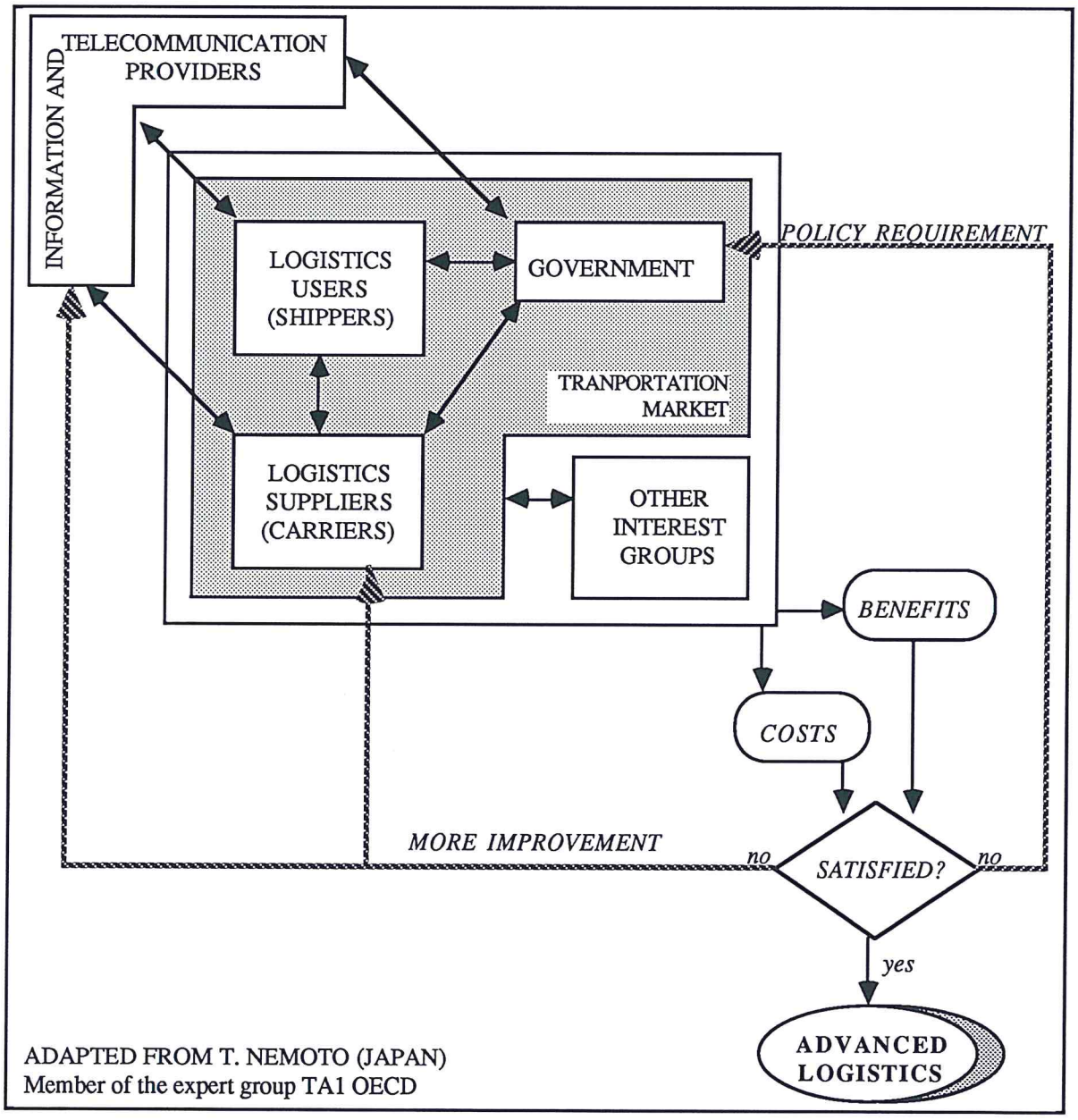
In all cases, the risk of bottelnecks is high and it becomes a real "transport policy" problem. Some countries are trying to equilibrate transportation by limiting, or at the opposite by stimulating, the development of warehousing in dedicated areas. The fact is that localization of logistics physical units, whether they are manufacturing plants, warehouses, or stores, directly depends on infrastructure capacity and the economic activity of the area.

The role of information and telecommunication technologies must not be forgotten in this field : it could facilitate the decentralization of back offices within metropolitan regions and into non-central regions. But while it is relatively easy, technically if not legally, to "dematerialize" clerical work, it is much more difficult to break loose from the constraints of infrastructure that have physically marked our cities and countryside for a century.

- 3 - *EVOLUTION OF THE TRANSPORTATION SECTOR ITSELF*

At this stage of the presentation of backgrounds of advanced logistics systems, we have pointed out the main evolutions in logistics users demand and in government policies, both actors who have direct linkage with logistics providers (as illustrated by the figure 2). The evolution in transport sector itself must now be examined.

FIGURE 2 : SITUATION OF LOGISTICS SUPPLIERS



3-1- EVOLUTION OF THE TRANSPORTATION SERVICE

The analysis of shippers' demand reveals the existence of a freight transport market in the true sense of the term, characterized by the diversity of goods, destinations, batch sizes, and frequency of delivery. In response to the fast multiplying and increasingly sophisticated needs of shippers, the transport sector has been developing a variety of new services. The main trends of evolution are : sophistication and diversification of existing services, inauguration and development of new services, entrance of transportation firms into other areas of logistics business. What are the impacts of this general evolution of the transportation sector on road freight activity?

3-1-1- FROM MODAL TRACTION TO LOGISTIC SERVICE

- **Transportation from the modal view to PLURIMODAL management**

Previously transport chains tried to avoid changes in transportation mode, considering each change as an interruption in flows. Now, these operations are not only more rapid and reliable, but some added-value can be created in the points where they are performed. Thus, in transport chains, all modes of traction (in the sense of pure transportation) can intervene successively or alternately. All modes, previously independent, have become combined, and have to collaborate in planning, controlling and piloting the whole chain they are associated in.

This contribution to a unique service (the transportation chain) is not so easy because of the necessary management of mixed technologies (sometimes with various generations), because of the multiplicity of information exchanges between an increasing number of partners who have different systems. The complex links between logistic chains and transport chains and the general subjection to the tension of flows are factors which increase difficulties, and point out the normalization constraints at the physical level and at the information processing level, a phenomenon which is accelerated by the development of networks.

The road freight transportation sector is facing a tricky situation. It has to insert itself in this multimodal transport environment. But will it be as a simple subtractor of other modal operators (sea, air or rail carriers)? Is it powerful enough to take part in the multimodal transportation planning? Can it make a real contribution to the definition of common standard (in particular in communication exchanges)? Will it be able to develop the required information systems to control transport chains and to fulfill the quality that shippers ask for?

• **Integration of other LOGISTIC SERVICES**

The service provided under the "transportation stamp" now includes basic transportation (traction), storage, handling, warehousing, even packaging, and sometimes production (assembling). In overall logistics costs, the pure transportation component is not the most important part. And most carriers consider that, due to ever declining rates of transport prices, benefits are not possible if they exclusively perform a traction activity. That explains why many transport carriers are adding more lucrative logistic services to their basic transportation activity. Some of them even get rid of the transportation activity itself (they subcontract to "real carriers") to focus on other logistics services.

The best examples are shipping companies with containerization, and air freight carriers with express door-to-door services. Railroad companies also try to develop door-to-door services. To guarantee the quality of the whole chain, they sometimes try to control (when they don't become) road carriers to achieve global service. In this kind of evolution many road carriers may be threatened to lose their autonomy.

But, road hauliers also extend their activities to other logistics services. The flexibility of road transportation, its possible rapid adaptation to the quantity of goods to move, represent great opportunities for adavanced logistics systems designed to handle a smaller volume of mixed freight with a wider variety on a JIT basis. Consequently, road carriers have to develop warehousing, handle break-bulk points, and develop information and systems in order to track shipments and control stockholding.

This new activity, performed in the nodal points of transportation networks, makes road carriers closer to shippers. Therefore, they can easily adapt the service to the particular needs of their customers. In stockholding for example, they can mix stockless management for nearby exchanges, and higher inventory control in foreign trade (where transportation chains are longer, less frequent and less punctual and with more complex administration).

3-1-2- THE RECONSTRUCTION OF PHYSICAL NETWORKS

Logistics decision "power" includes the choice of the physical units localization (plants, warehouses, etc), whether logistics activities are contracted out or not. In recent years, firms have reduced the number of their warehouses, in order to centralize their storage and distribution operations in larger premises with higher technical specifications. By concentrating inventory in fewer locations they could achieve substancial stock reduction (See II-1-1-2) while taking advantage of economies of scale in warehousing (cost reduction in operations).

The increasing tendency for manufacturers and multiple retailers to externalize the physical distribution function has also affected the pattern of demand for warehousing. Stock previously held in shippers' own distribution depots are being consolidated in larger warehouses set up by specialist contractors, who are often also transportation operators.

- **The KEY-ROLE of nodal points**

The reconstruction of transportation networks observed now shows a greater importance of terminals (nodal points) which are much more than simple warehouses. Although improvements in road transport have eased the technical constraints on the spatial concentration of stockholding, logistics is performing a high proportion of the deliveries via satellite transhipment depots or by means of demountable transportation systems. By divorcing the storage and break-bulk functions and sometimes performing them in different locations, firms have been able to reconcile conflicting transportation and stockholding cost objectives. The transhipment depots are even increasingly replacing conventional warehouses, particularly in more peripheral areas.

The basis of physical networks, even in a world-wide organization, are now the nodal points. In JIT organizations for example, where direct line haulage cannot provide a truck-load every shipment, capacity utilization of trucks is obtained by reducing the number of terminal links and combining various shipments (sometimes with a modular loading systems like containerization).

This "hub-and-spoke" system is not new and is natural in an activity which demands both full loads (to the fleet profitability) and high frequencies (to the service level). Bulking is a necessity for freight services and the concentration of freight is an apparent phenomenon in shipping (with ports) and railroads (with marshalling yards). What is new in road freight, is their networking structure and their computerized management which make them more efficient in rapid flows.

- **The COMPLEX management**

But the successive consolidation of goods flow and of information, can lead to bottlenecks which ruin the logistics perfomance and costs benefits, in particular when a high speed transportation service is required. Logistics suppliers must improve their operating productivity in sorting large quantities of goods and information, to avoid stagnation of freight and transportation delay. The increasing scale and sophistication of mechanical handling systems, moving towards automated warehousing, is certainly a revealing factor of this search for productivity. Companies must also fight the risks of bottlenecks when receiving trucks or other transport vehicles in those nodal points. New terminal facilities and planning systems to organize transport access are necessary to eliminate any waiting time of transportation vehicles.

But the polarization effects that nodal points are creating do cause management problems that explain the development of advanced logistics systems. And the more complex is the service provided, the more difficult its organization is. It is the case when logistics suppliers try to superimpose networks and mix different customized services.

Information and communication systems are necessary to have direct connections to customers and other logistics suppliers systems, in order to improve the links between logistics chains and physical flows, and to guarantee the physical flows will not be slow because of the slowness of information processing (whether they are paperless or not). In this context, physical nodal points are also becoming the structuring points of the information and communication networks of the advanced logistics systems.

3-2- ABOUT THE EVOLUTION OF TRANSPORTATION FIRMS

3-2-1- TRANSPORT OPERATORS' SPECIALIZATION

Because of the greater competition between transportation firms, each one tries to specialize in different logistics services. Their supply try to meat the shippers demand in each specific field demanded. The result is a real market segmentation, based upon organization of intermodal transportation, hub-and-spoke structure of transport networks, standardization of packaging, mechanized handling and pricing structure. Some types of specialization can be outlined.

The specialization by logistic family of products permits to reinforce activities by grouping goods that are logistically compatible. Shipping round tour, mixed load shipping and scheduled shipping are possible and developed. This specialization exist for example in JIT car manufacturing parts supplying, in fresh food or wines and spirits transportation, or in sensitive (dangerous) goods transportation.

The specialization on particular gaps of the logistic market permits economy of scales by becoming the specialist of a special service. It is the example of logistics services like rapid collection and distribution of small shipping quantities, or like coat hanger clothing delivering.

A kind of specialization can also be found in developing specific networks to forward the massive flows of goods generated by proactive logistics with a high productivity level (the example in chain stores distribution), and/or in developing specific networks to forward specifically goods generated by a reactive logistics with a high service level (the example in providing parts in a logistic support service). The transportation fleet and the physical network is adapted to the routes, to the volume to move and the frequency of deliveries.

3-2-2- DUALISM AND HIERARCHY OF THE TRANSPORTATION SECTOR

The result of the develoment of advanced logistics systems, highly specialized and efficient, but with complex management resources, is the dualism and hierarchy of the transportation sector, in particular in road freight transportation. On one side there are the transport subcontractors, with little autonomy, only involved in technical operations of low added-value. On the other side there are transport chains organizors and managers who benefit from their capacity to mobilize multilple actors, techniques and networks.

This evolution is speeded-up by the concentration of factories and distribution centers which enables shippers to centralize the decision making with respect to the choice of operators on a wider area basis. For the operator this means that he must be able to offer the whole range of transportation services. This evolution lead obviously to a concentration on the side of logistics suppliers, and to a widening gap between organizors and subcontractors.

In most countries the majority of medium and small business scale road freight companies are modal operators inserted in chains they do not manage. A few large-scale trucking companies with a number of service offices and terminals throughout the country, and with information and communication systems in progress, have constructed a nation-wide transportation network covering all areas. They offer a complete logistic service, and are able to connect with other networks, in particular for international trade.

In the future, only few mega-companies will probably offer all modes of transport and full logistics services. By means of mergers and take-overs they will build wide networks linked by an advanced information system (the harmonization of this network will undoubtedly be hard!). These companies will invest relatively little in vehicles since the pure transport activities will be contracted out to smaller operators. On the other hand they will invest large amounts of money in computer and communication technologies. These mega-companies will be the architects of transport chains, while subcontractors will do the present trucking.

Besides, some operators are specialized in products and/or areas (product/market combinations). The position of this group of specialists will remain largely unchanged. But medium-sized operators run the risk of falling in between mega-companies and subcontractors. By co-operating with other supplementary medium-sized companies they will perhaps be able to build their own area-wide network (both physical and information). By this strategy, co-operators can play an important role in road freight transportation, altough they never reach the size of mega-companies. They will have to build co-operative network and systems that are also difficult to implement.

3-2-3- CHANGES IN THE KNOW-HOW AND IN THE CULTURES

For the transportation sector, the development of logistics has resulted in many changes. The complexity of the services provided has speeded-up development of the know-how in logistics, information processing and marketing. New skills are necessary and the sector is taking on higher qualified worker than before. The transportation activity becomes a genuine industrial activity with a real management, but for this kind of transport, firms must invest in know-how and software : both "non-material" investments.

The variety of physical operations involved in a transportation chain, and the need to synchronize them in accordance with the logistic chain, tend towards the transformation of old professional mode-centered cultures and the decline of firm cultures marked by the paternalism of the road sector. Phenomena in the structure sector as vertical integration (to fullfill more services), or horizontal integration (to cover a greater area or to move more products), participate to the evolution too. The situation is also obvious for logistics suppliers who have no trucks of their own and lease them, and generally do not even own their warehouses which they rent (that means that they have to subcontract some activities to others). Their investment is entirely intangible. This type of skill, that may be qualified more in terms of expertise than mere specialization, combines communication and management techniques.

The road freight sector seems to be more open-minded to advanced logistics systems. This is confirmed by the trends in innovations.

For a long time, innovation in the transport sector had tended to occur only in transportation techniques (vehicles, civil engineering...) rather than in its management or organization. This was mainly due to the fact that operators had little freedom of action. Hence, progress in the transport sector tended to be seen essentially in technological terms, rather than in terms of commercial and organizational innovation where the potential for development is in fact considerable. This explains why firms are now interested in logitics systems and why they focus on their development.

In all countries, computers investments are increasing in the road freight transport sector, even if it is late compared with other modes (air or shipping). But if information and communication systems are undoubtedly necessary to perform the physical flows management, again large companies will have better possibilities than small ones, since they can afford the financial and human resources needed.

- 4 - TYPOLOGY OF LOGISTIC INFORMATION AND DECISION SYSTEMS

We are now entering a new phase of the logistics evolution, in which new information and communication technologies offer great potential not only for modifying the individual process stage of production storage, transportation and transactions, but also, and in a more important way, for changing the integration of the process stage in the logistics chain into more efficient, but more complex systems. The quality of the information system along the logistic chains as well as the level of sophistication of the decision support systems contribute to higher productivity and less uncontrolled fluctuations.

Before examining the main evolution of information systems in transportation, it seems necessary to have an idea of the systems developed by firms on the "demand side", at least the systems they would like to develop. This shows the information systems situation in which transport firms will have to insert in.

4-1- LOGISTIC INFORMATION AND DECISION SYSTEMS IN SHIPPERS ORGANIZATION

4-1-1- INTERNAL SYSTEMS TO FOLLOW THROUGH OPERATIONS

The use of information technologies for the automation of manufacturing or handling processes has progressed in the 1980's. The evolution can be classified in four stages :

Stage 1 : automation of individual equipment

Labor saving by introducing high performance equipment such as numerically controlled machine (NCM) and flexible manufacturing system (FMS).

Stage 2 : automation of the whole process

Introduction of automatic conveying and automatic warehousing systems in physical operations, of computer-aided engineering in R&D sector and of computer-aided design in design sector.

Stage 3 : automation of corporation as a whole

Automation of the whole corporation by integrating sales, design and production sectors.

Stage 4 : computer integrated manufactuting (CIM)

automated individual sectors are integrated, a network is formed with computer and information technology, sales information is transmitted to marketing, R&D, design and production sectors through local area network (LAN), and each equipment such as NCM is operated under the control of the total system.

The logistics objective of all those systems consists in : the global planning of physical flows (if possible directly driven by the market), the follow through of all operations in order to detect hazards (tracking), and if necessary the activation of backup networks to overcome negative effects of hazards.

Some questions immediately arise. How will interface with the transportation systems operate? Is not the gap between shippers' culture and that of transport operators a problem?

4-1-2- INTERNAL SYSTEMS TO ENSURE TECHNICAL OPERATIONS

Of course the internal organization cannot be efficient if the logistic supply is not adequate. Shippers have extended their systems and built internal systems that gather information about external circulation and give it to the internal system.

The objective of those systems is first the optimization of operations fulfilled by the transport operator, from the shipper's point of view. It is also to improve the internal coordination in particular the technical optimization of the interfaces with the transport chains (for example by shortening inspection time at the interface with transportation). For example, in JIT organization, it is necessary to synchronize the parts delivering with assembling and with inventory management.

The very difficulty is to provide reliable data though improved management information systems.

4-1-3- EXTERNAL SYSTEMS TO ENSURE NECESSARY INFORMATION INTERCHANGES BETWEEN PARTNERS

Advanced logistics systems are supposed to be based on more cooperation between parts suppliers, manufacturers, distributors and logistics suppliers. This cooperation which tries to give more mutual benefits to partners, suppose the development of information systems to insure an adequate circulation of goods and information between partners.

Systems should produce the synergism within partners stuck together into a chain (to accord with daily fluctuation of demand, to adjust mutual production as flexibly as possible). Then they should ensure data interchanges that are necessary to produce transport operations.

Following effects are researched : quick, accurate easy ordering, high frequency ordering for required amount, shortening delivery time preventing the absence of stocks, reducing inventories, reduction in labor hours, in processing errors, in returned goods (reduction of incorrect delivery)...

If industrial firms want to reduce the global business cycle, they have to lower inventories and to synchronize operations all along the logistic chain. Increased speed of physical flows will require a more efficient information and communication system. The first characteristic will be faster communications. But faster communication systems can cause nervousness and instability, and may require "expert systems" to sort information out and make it useful and aviable as rapidly as it circulates.

Is the transportation sector capable of fulfilling this requirement?

4-2- INTERNAL SYSTEMS OF TRANSPORTATION FIRMS

This part presents a typology of logistics information systems which are, or are to be developed in transportation. Without describing them in a technical way, we woud like to show how they respond to the logistic demand.

4-2-1- ROUTING MANAGEMENT

Beginning with transportation activities, many systems are in progess.

For the fleet management itself, we can notice software for fleet management (vehicles, containers, packages...), and software for route management, including the planning of routes and sometimes overcoming momentary congestion of facilities. Notice that some radio-guidance and traffic control facilities gathering information regarding traffic conditions and giving such information to drivers for safe and smooth flow of traffic, could help drivers to choose between different routes, especially in urban areas and during peak holiday periods.

Those systems are complemented by other systems dedicated to track vehicles (via satellite observation), and to revise routing (in embarked communication systems). Those systems include navigation help (localization, trafic congestion information, optimization of travel), information services (digital road map), communication services. Sometimes, long-distance routes are divided, links are coordinated at relay stations.

Some systems, connected to dispatched equipment, can also perform computer-aided maintenance of the sensitive mobile equipment (those on critical paths in the network for example).

Another family of systems in routing management are shipment tracking systems which can accurately identify the location of goods and make sure the network is operating normally. This kind of system is based on the network-wide online system, and above all on the identification, codification, or symbolization of lots and consignments (with bar-codes, tags....).

At certain points in the transportation process (when parcel is collected, when it arrives in or comes out at each terminal, and when it is delivered), information about the parcel is entered from shipping slips to terminal units and memorized one by one in the host computer through communication lines. Therefore the computer keeps track of the location of all parcels. If a customer asks for the arrival date or wants to check the arrival, then the retrieval can be made by merely inputting the slip number in a terminal unit, and it is thus possible to answer the customer immediately on the location of the particular parcel.

Such a system is also able to control the process of transportation. In this systems the computer checks the destination of the truck and the destination of each parcel loaded in the truck, and also the computer checks whether the delivery of the parcel is wrong or not. These are useful for preventing incorrect or missed shipment or other accidents, thereby further enhancing the stability of transportation. This kind of freight following system has resulted in qualitative improvement in transportation services which were not possible previously.

4-2-2- THE MANAGEMENT OF FIXED LOCATION OPERATIONS

In the other logistics services, systems are also in progress.

Computerization and automatization is observable in warehousing and stock control, in picking, in delivery preparation, in stocks management, in sorting out, in packaging systems, in just-in-time and synchronous delivery management...

This kind of system is in general associated to systems dedicated to manage the reliability of complex equipment. They perform computer-aided maintenance of the sensitive static equipment (at the bottlenecks for example).

But logistics efficiency does not result from the accumulation of systems. The benefits from transportation chains, the internal profitability of each link and the global profitability of the whole chain, can only be realized through the synergism between the multiple systems that are developed. The introduction of nation-wide online system is necessary, first internal in the company network, then opened to transport subcontractors. Communication among the headquarters, branches and local business offices can support the collection and distribution of corporate news, information about freight transport control, and is also able to conduct quick and efficient processing of enormous clerical work and communication in trucking companies. The online system is formed by connecting the central computer to the terminal units at each service office with communication lines. Sometimes it is also connected to mobile computers in each vehicle of the fleet.

But because of the necessary reliability of the logistics provided service, those internal systems will have to be able to converse with shippers in order to achieve global communication.

4-3- SYSTEMS BETWEEN FIRMS

4-3-1- INTERCHANGES AND RESTITUTIONS OF INFORMATION BETWEEN LOGISTIC PARTNERS : TOWARDS EDI

Exchanging information about transportation can take more time than transportation itself, specially in road transportation. Looking for a greater speed in this field, transportation firms are looking for electronic transaction functions (with EDI systems) for : booking, ordering, delivering, billing... The recent development of so-called VAN services and their use in trucking business makes freight tracing, data collection, message interchange... easier and more efficient.

The clerical work (performed in each place where the parcel is passing through) requires a linkage between services that then requires communication. For this reason, the exchange of shipping slips, distribution of freight charges, business contacts, etc. occur between offices or terminal, even shippers. As the number of parcels increases, enormeous quantity of clerical work and communications will greatly expand. Thus conventional processing, which relies upon human labor forces and ordinary tele-communications, could not handle the new situation.

Delivery plans are automatically sent to the transport companies, which often use them to adjust their hauling capacity for the most efficient loading possible.

Interfirm and international computer integrated logistics will be the dominant change agent for the future. Hence, the bottleneck for improvement might be in communication standardization, lack of capacity and antique regulation (legal one for example) that prevent innovative service developments.

4-3-2- INFORMATION GENERATED, ENRICHED, THEN GIVEN TO PARTNERS : TOWARDS REAL VAN ?

Present EDI technics only increase speed and reliability in communication. They do not add any value to information itself. Logistics will need real value added networks to manage quality and to avoid interuptions in goods flow.

CONCLUSION

As a conclusion, we would like to underline the actual situation of road haulage operators. The future of these operators relies on their capacity to insert themselves into the information and decision systems of their customers (the shippers). The problem is : will they have to create private systems, or, as the present tendency seems to show, will they use a part of a global system?

This question have important consequences.

-Will EDI standards be broken into segments, each segment corresponding to an industrial sector? If so, transport operators would be bothered because they operate in many of them.

-Will EDI standards specific to transportation be developed? If they will, they must be compatible with the standards of all sectors that interface with transport.

-Considering the national characteristics of the transportation market, how will the problem of international standardsbe resolved?